MODULE-2

Information Representation

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Multimedia Information Representation:

All types of multimedia information are stored and processed within a computer in a digital form. like when we enter strings of character from keyboard, each character is represented by a unique collection of fixed numbers of bits known as codeword.

Computer generated graphical Images are made up of a mix of lines, circles, squares & many more. each represented in a digital form.

Also devices such as microphones and many video cameras produce electrical signals whose varies continously with time.

The conversion of analog signal into a digital form is carried out using an electrical circuit known as a signal encoder. and similarly the conversion of the stored digitized samples relating to media type into their corresponding time varying analog form is performed by an electrical ckt. known as signal decoder.

DIGITIZATION PRINCIPLES:

Analog Signals:

The amplitude of an analog signal varies continously with time. The range of frequencies of the sinusoidal components that make up a signal is called the signal

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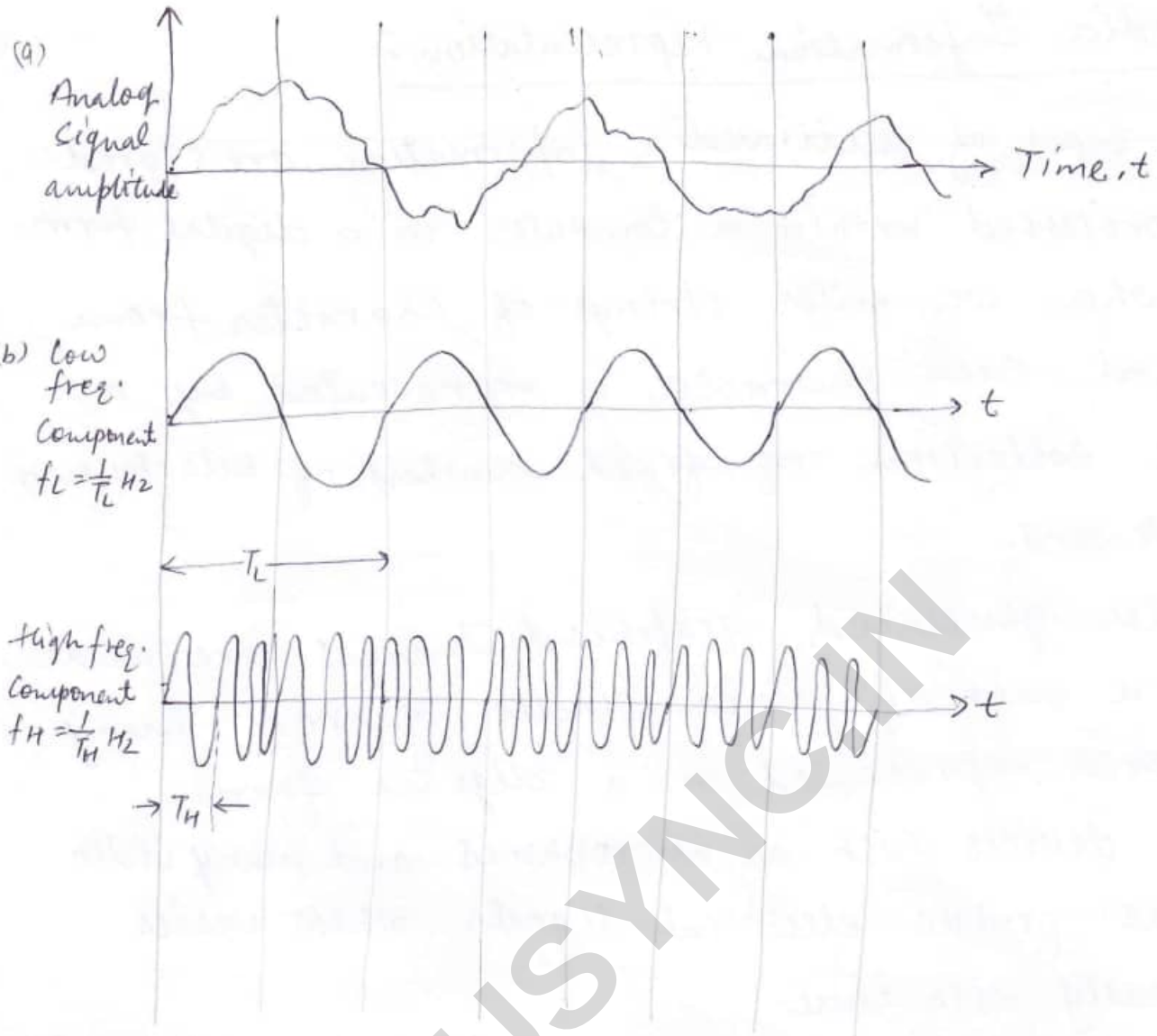
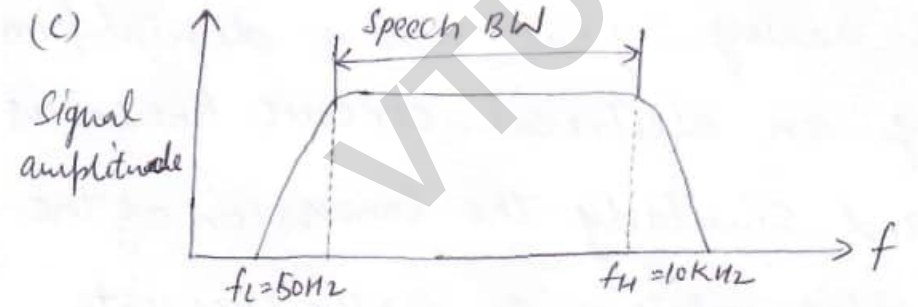
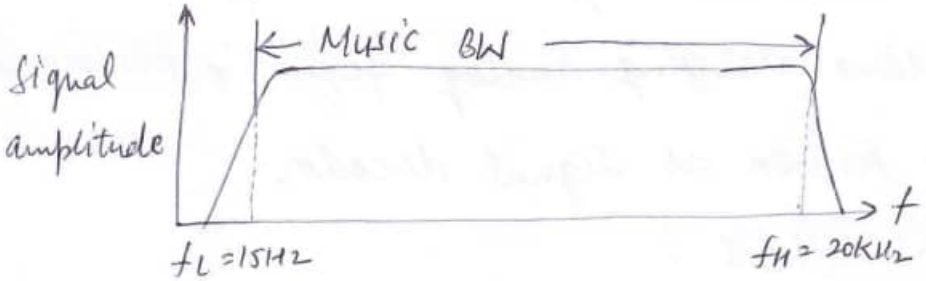
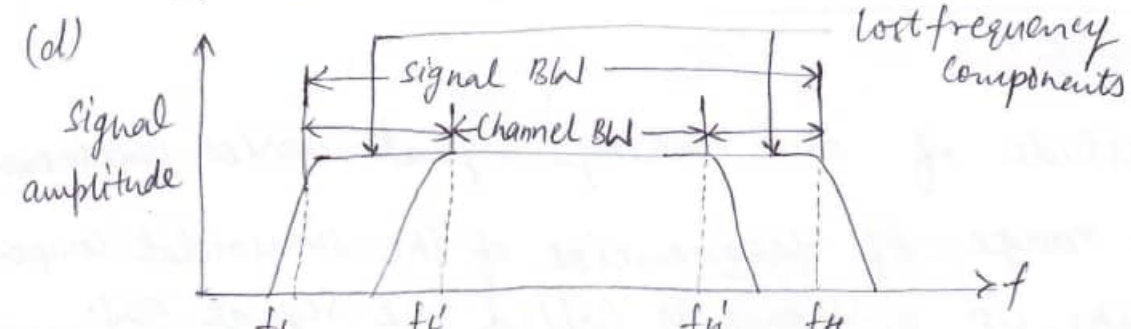

(a)
Analog signal amplitude
Time, t
(b) Low freq. Component
$f_L = \frac{1}{T_L}$ Hz
T_L
t
High freq. Component
$f_H = \frac{1}{T_H}$ Hz
T_H
t


(c)
Speech BW
Signal amplitude
f
f_L = 50Hz
f_H = 10KHz


Music BW
Signal amplitude
f
f_L = 15Hz
f_H = 20KHz


(d)
Signal amplitude
signal BW
Channel BW
lost frequency components
f
f_L
f_L'
f_H'
f_H

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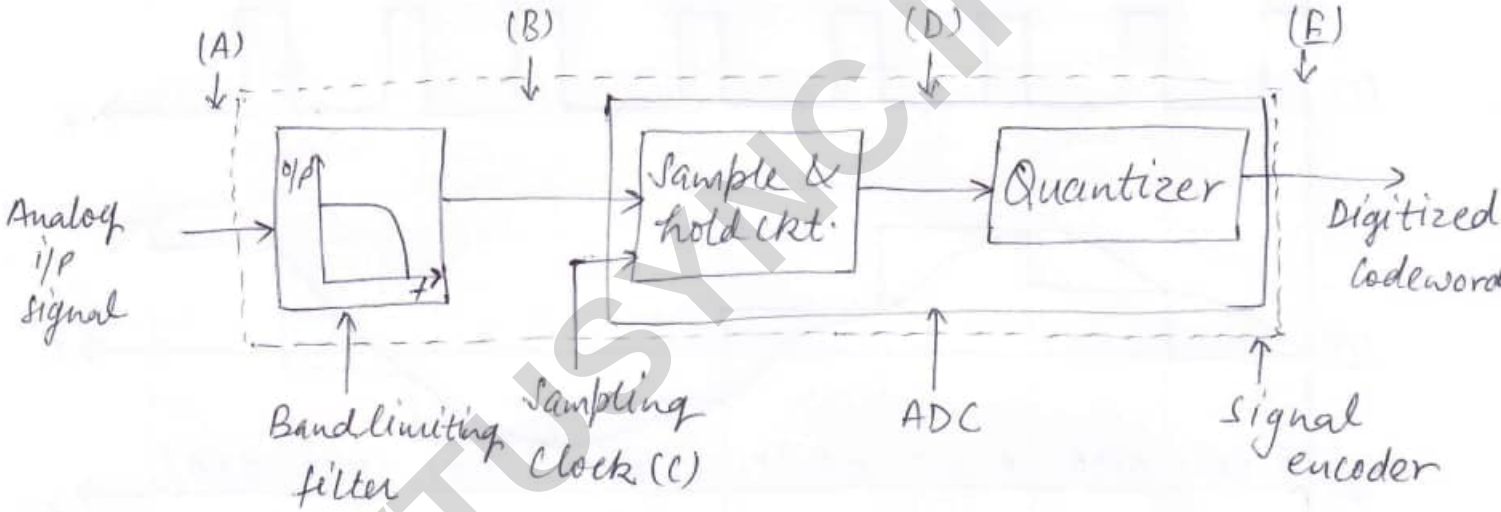
When an analog signal is being transmitted through a n/w, the BW of the transmission channel should be equal to or greater than the BW of the signal.

ENCODER DESIGN:

Encoder is a electrical circuit used to convert analog signal into digital signal. It consists of two main circuits: a bandlimiting filter and an A/D converter. ADC comprises of a sample & hold circuit & a quantizer.



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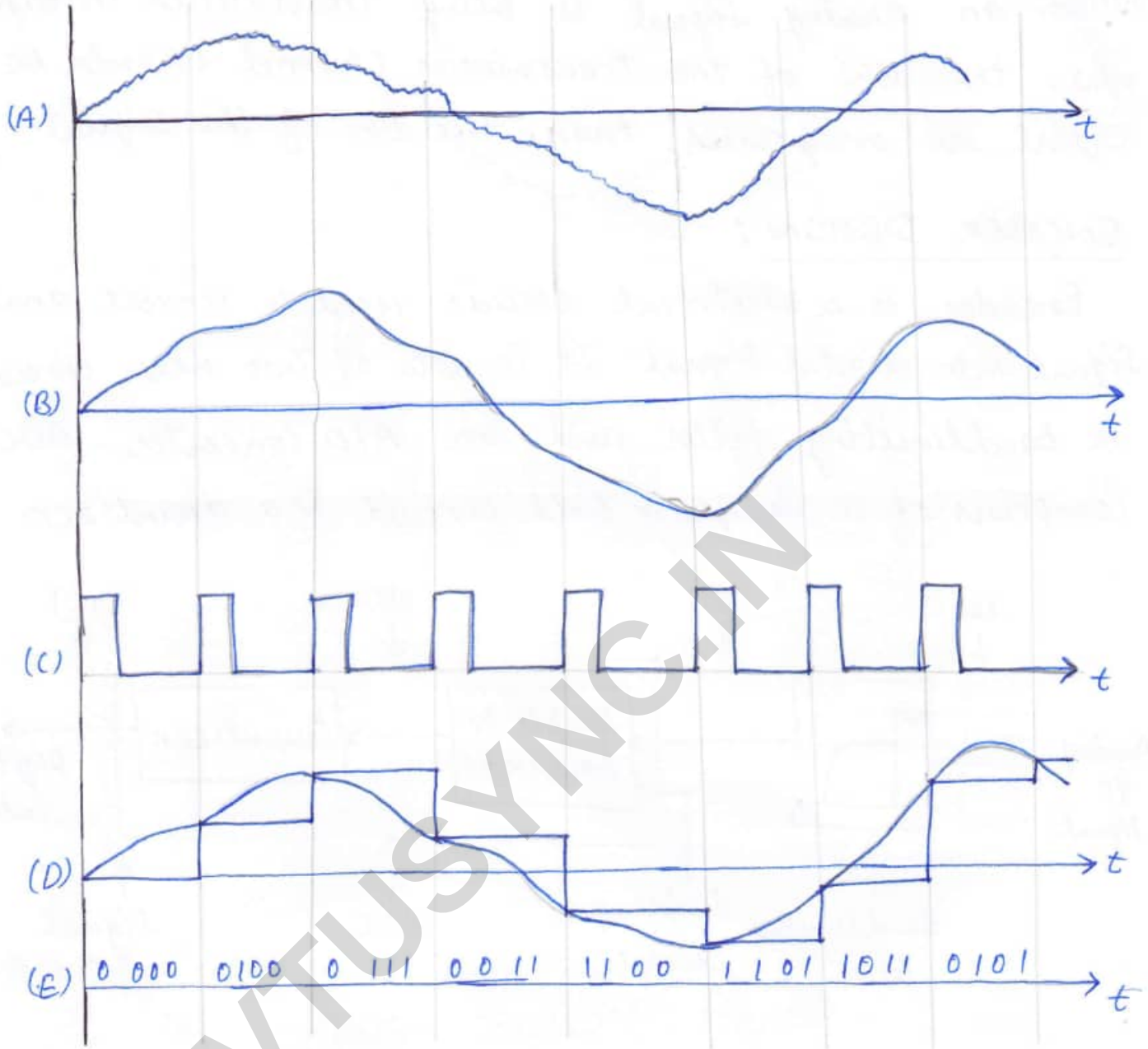
Bandlimiting filter is used to remove selected higher frequency components from the source signal. (A). The o/p of the filter is then fed to a sample & hold ckt. which is used to sample the amplitude of the filtered signal at a regular intervals & to hold the sample amplitude constant between samples. This is fed to quantizer ckt. which converts each sample amplitude into a binary value known as codeword.



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Sampling rate:

The amplitude must be sampled at a minimum rate that is equal to or greater than twice the highest sinusoidal frequency component. This is known as Nyquist rate.

The distortion caused by sampling a signal at a rate lower than the Nyquist rate. Such signals are called alias signals since they replace the corresponding original signals.

Quantization intervals:

If Vmax is the maximum positive & negative signal amplitude & n is the number of binary bits used, then the magnitude of each quantization interval, q, is given by

$$q = \frac{2V_{max}}{2^n}$$

The diff. between the actual signal amplitude & the corresponding nominal amplitude is called the quantization error. The error values will vary randomly from sample to sample & hence the quantization error is also known as quantization noise.

The ratio of peak amplitude of a signal to its minimum amplitude is known as the dynamic range of the signal, D.

$$D = 20\log_{10}(V_{max}/V_{min})\ dB.$$

DECODER DESIGN:

Analog signals are stored, processed and transmitted in a digital form, prior to their output, they must be converted back again into their analog form; loudspeaker. The electronic ckt. that performs this conversion operation is known as Signal Decoder.

Firstly each digital codeword is converted into an equivalent analog sample using DAC. This produces the signal whose amplitude of each level is determi

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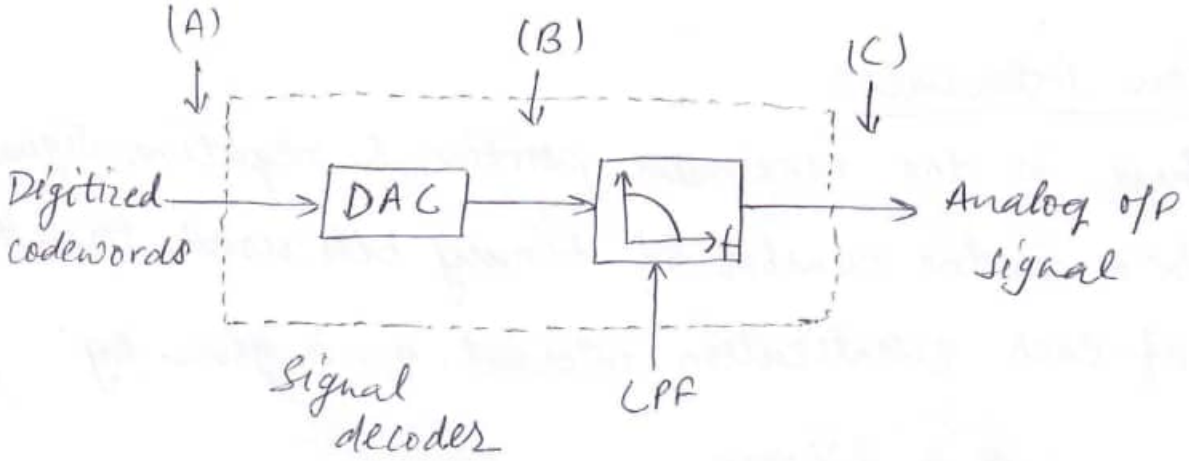
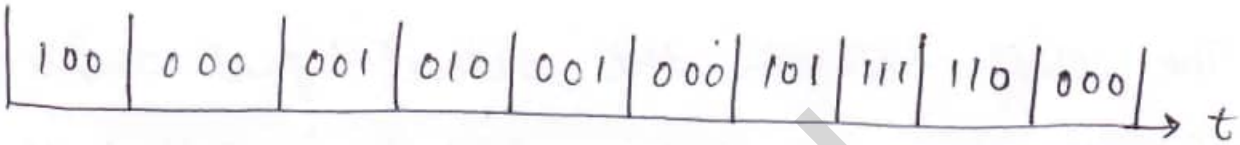
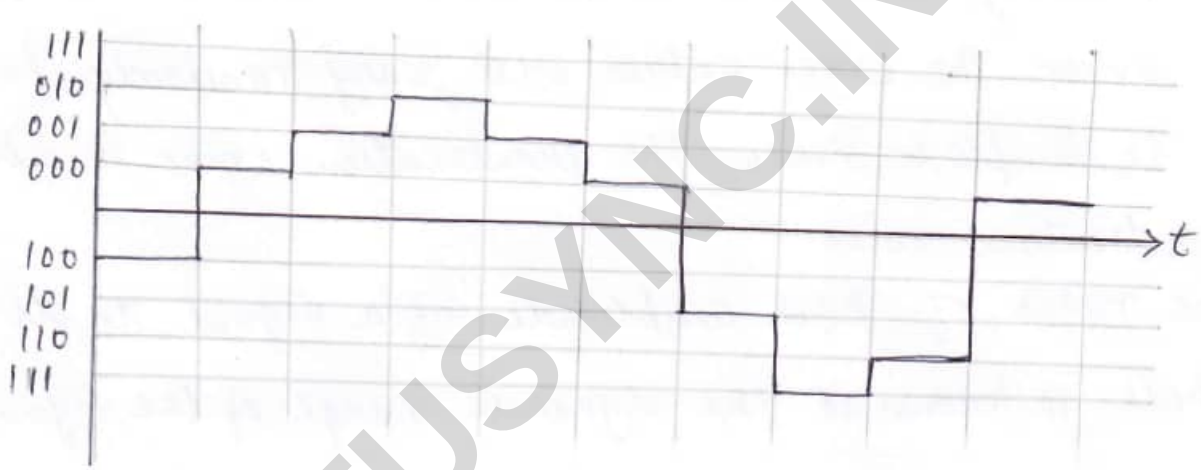


(b)





(b) Associated Waveform set.

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by the corresponding codeword. To reproduce the original signal, the o/p of DAC is passed through a LPF, which passes only those freq. component that ~~xxx~~ made up the original filtered signal

REPRESENTATION OF TEXT :

There are three types of text that are used to produce pages of documents:

⇒ Unformatted Text:

This is also known as plaintext & enables pages to be created which comprise strings of fixed sized characters from a limited character set.

⇒ formatted Text:

This is also known as richtext & enables page & complete documents to be created which comprise of strings of characters of different styles, size & shape with tables, graphics & images inserted at appropriate points.

⇒ hypertext:

This enables an integrated set of documents to be created which have defined linkages between them.

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UNFORMATTED TEXT:

This is also known as plaintext & enables pages to be created which comprise strings of fixed sized characters from a limited character set. All the normal alphabetic, numeric & punchtuatio characters refered to as Printable characters. The total ASCII charater set also includes a no. of control characters. These include:

⇒ format control characters: BS (backspace), LF (line-feed), CR (carriage return), SP (space), DEL (Delete) ESC (escape) & FF (form feed);

⇒ information separators: FS (file separator) & RS (record seperator);

⇒ transmission control characters: SOH (Start-of-Heading STX (start-of-text), ETX (end-of-text), ACK (acknoled NAK (negative acknowledge), SYN (synchronous idle) & DLE (data link escape).

FORMATTED TEXT:

It enables documents to be created that consist of characters of different styles & of variable size & shape, each of which can be plain, bold or italici A variety of document formatting options are supporte

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to enable an author to structure a document into chapters, sections & paragraphs, each with different headings & with tables, graphics & pictures inserted at appropriate points.

Hypertext:

Hypertext is a type of formatted text that enable a related set of documents referred to as pages. Hypertex can be used to create an electronic version of such documents with the index, descriptions of departmen courses on offer, library & other facilities all writte in hypertext as pages with various defined hyperlinks between them to enable a person to browse through it contents in a user-friendly way.

The linked set of pages that are stored in a particular server are accessed & viewed using a client program known as browser. Each set of linked pages is a page known as the home page.

The textual name of the link is associated with a unique network-wide name known as a uniform resource locator (URL).

An example of hypertext language is HTML which stands for Hypertext Markup language

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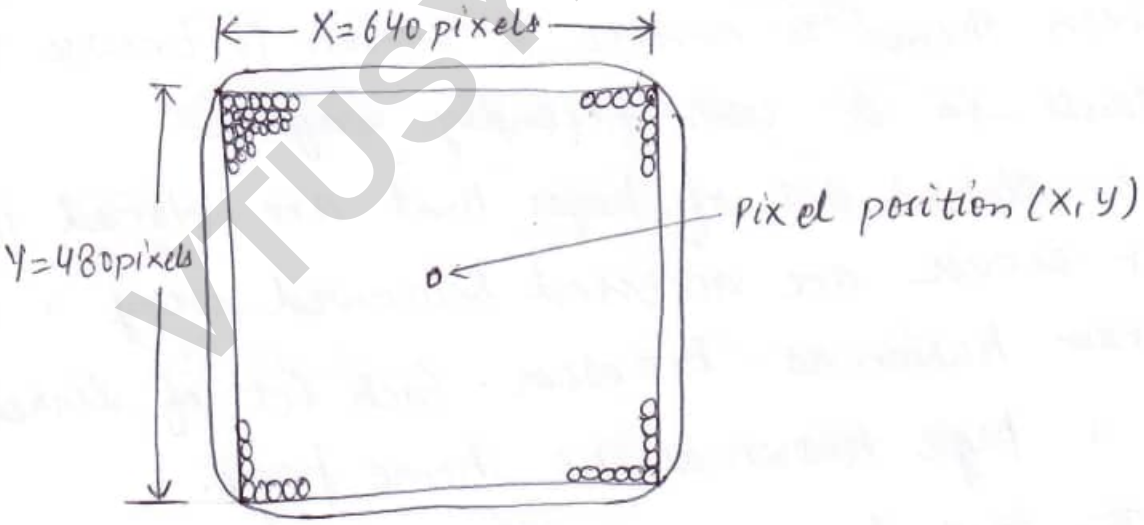
IMAGES :

Images include computer-generated images referred to as computer graphics and digitized images of both documents & pictures.

Graphics :

These are produced by drawing the desired shape on the screen by means of a combination of a cursor symbol on the screen - a pencil or paint brush like mouse. Textual information can also be included in a graphic, together with precreated tables & graphs & digitized pictures & photographs.



XXY = Spiral resolution of screen

8 bits per pixel = 256 different colors

(a) Screen format.

A computer's display screen can be considered as being made up of a 2-D matrix of individual pic. elements - pixels - each of which can have a range of

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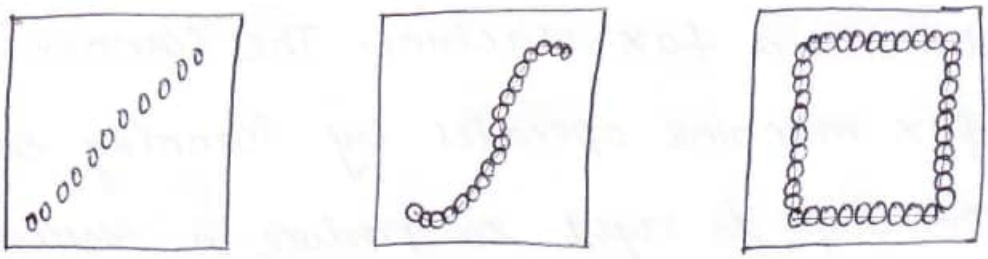
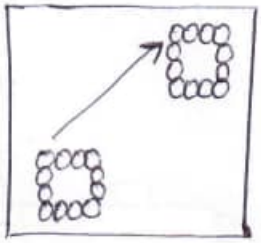
(b)



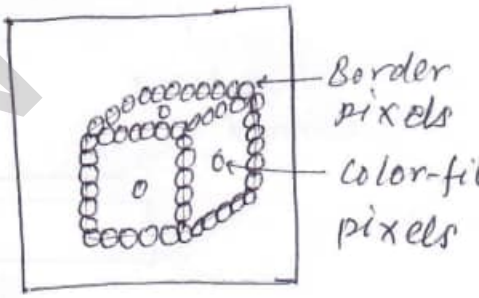
(b) Simple object example

(c)



effect of changing position attribute.

(d)



Solid objects

Colors associated with it.

All objects are made up of a series of lines that are connected to each other. Some of simple example examples are shown in fig (b.). Each objects has a number of attributes associated with it. These includes its shape a line, a circle, a square &so on. Editing an object inoolves simply changing selected attributes associated with the object. As shown in fig. (c) we can move a square to a diff. location on screen by simply changing its border coordinates

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Digitized Documents:

A digitized document is produced by the scanner associated with a fax machine. The scanner associated with a fax machine operates by scanning each complete page from left to right to produce a sequence of scan lines that start at the top of the page and ends at the bottom.

As each line is scanned, the output of the scanner is digitized to a resolution of approx. 8 picture elements known as pels with fax machines / mm.

Digitized pictures:

In case of scanners which are used for digitizing continous-tone monochromatic images, normally more than a single bit is used to digitize each picture element. These yields 256 diff. levels of gray per element. Varying blw black & white.

Colour Principles:

A human eye sees just a single color when a particular set of three primary colors are mixed & displayed. [illegible]

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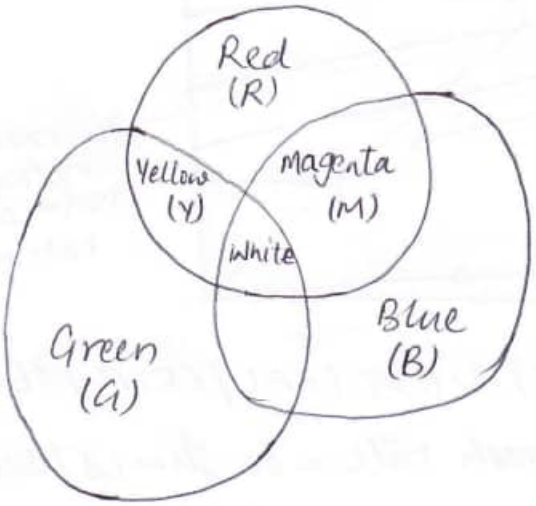
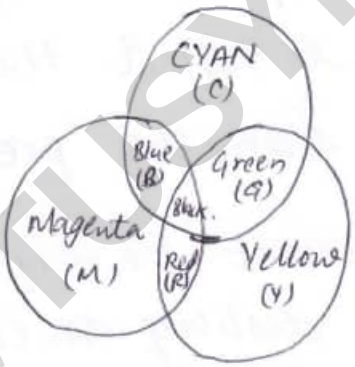
known as color gamut, can be produced by using diff. proportions of three primary color Red, Green & Blue.



(a) additive color mixing.



(b) Subtractive color mixing.

Raster-Scan Principles:

The picture tubes operate using a raster-scan principle. This involves a finely-focussed electron beam being scanned over the complete screen. Each complete scan starts at the top left corner of the screen & the last which ends at the bottom right corner. This type of scanning is called progressive scanning.

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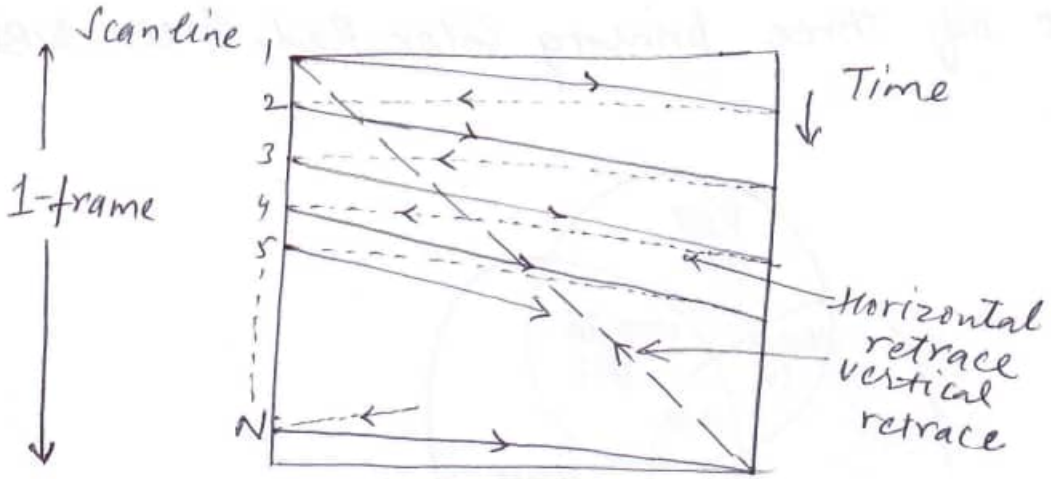

N = 525 (NTSC) & 625 (PAL/CCIR/SECAM)

frame refresh rate = 60 times/sec. (NTSC)

= 50 times/sec (PAL/CCIR/SECAM)

Television picture tubes were designed to display moving images. In case of moving images, the light signals associated with each frame change to reflect the motion during the time required to scan the preceeding frame. The frame refresh rate must be high enough to ensure the eye is not aware the display is continously being refreshed.

Aspect Ratio :

Both the no. of pixels per scanned line & no. of lines per frame vary, the actual no. used is determined by the aspect ratio of display screen. This is the ratio of screen width to screen height. The aspect ratio of current television tubes is 4/3 with older tubes & 16/9 with wide screen television tubes.

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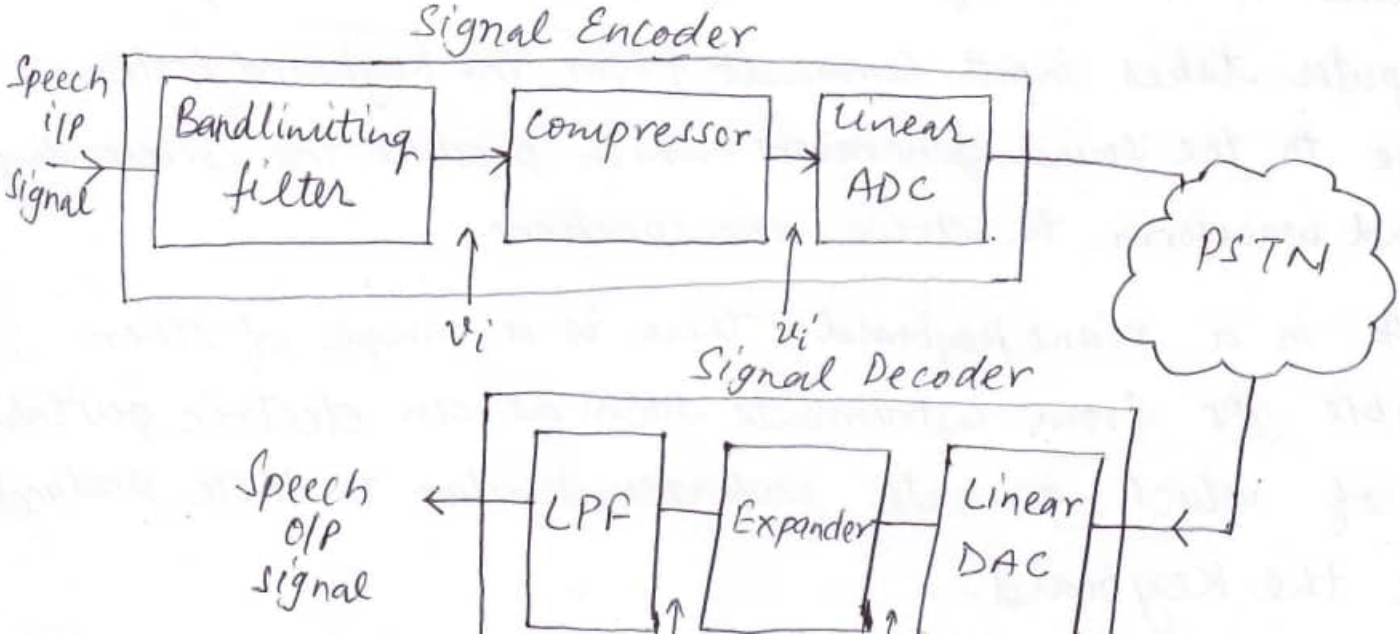
AUDIO :

We are concerned with two types of audio signal Speech signal as used in a variety of interpersonal applications including Telephony & video telephony & music-quality audio as used in applications such as CD-on-demand and broadcast television. Audio can be produced either naturally by means of a microphone or electronically by using some form of synthesizer. The BW of a typical speech signal is from 50 Hz – 10 KHz. and that of music signal is 15Hz-20 KHz.

PCM Speech :

Most interpersonal applications involving speech use for communication purposes a PSTN. Initially, a PSTN operated with analog signals throughout, the source speech signal being transmitted and switched unchanged in its original analog form.



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As we can see, both the encoder & decoder, consist of two additional ckts: a compressor and an expander. The role of these ckts is quantization, irrespective of magnitude of the i/p signal, the same level of quantization noise is produced.

CD-quality Audio:

The discs used in CD players & CD-ROMs are digital storage devices for stereophonic music & more MIS. Music can be audible b/w 15Hz - 20KHz & hence the minimum sampling rate is 40Ksps.

Synthesized Audio:

Any form of audio can be stored with in a computer. The amount of memory required to store a digitized audio waveform can be very large, even for relatively short passages.

The three main components are the computer, the keyboard & the set of sound generators. Essentially, the computer takes input commands from the keyboard & o/ps these to the sound generators which produce the corresponding sound waveform to drive the speakers.

As in a piano keyboard, there is a range of other possible i/ps from instruments such as an electric guitar all of which generate messages similar to those produced by the keyboard.

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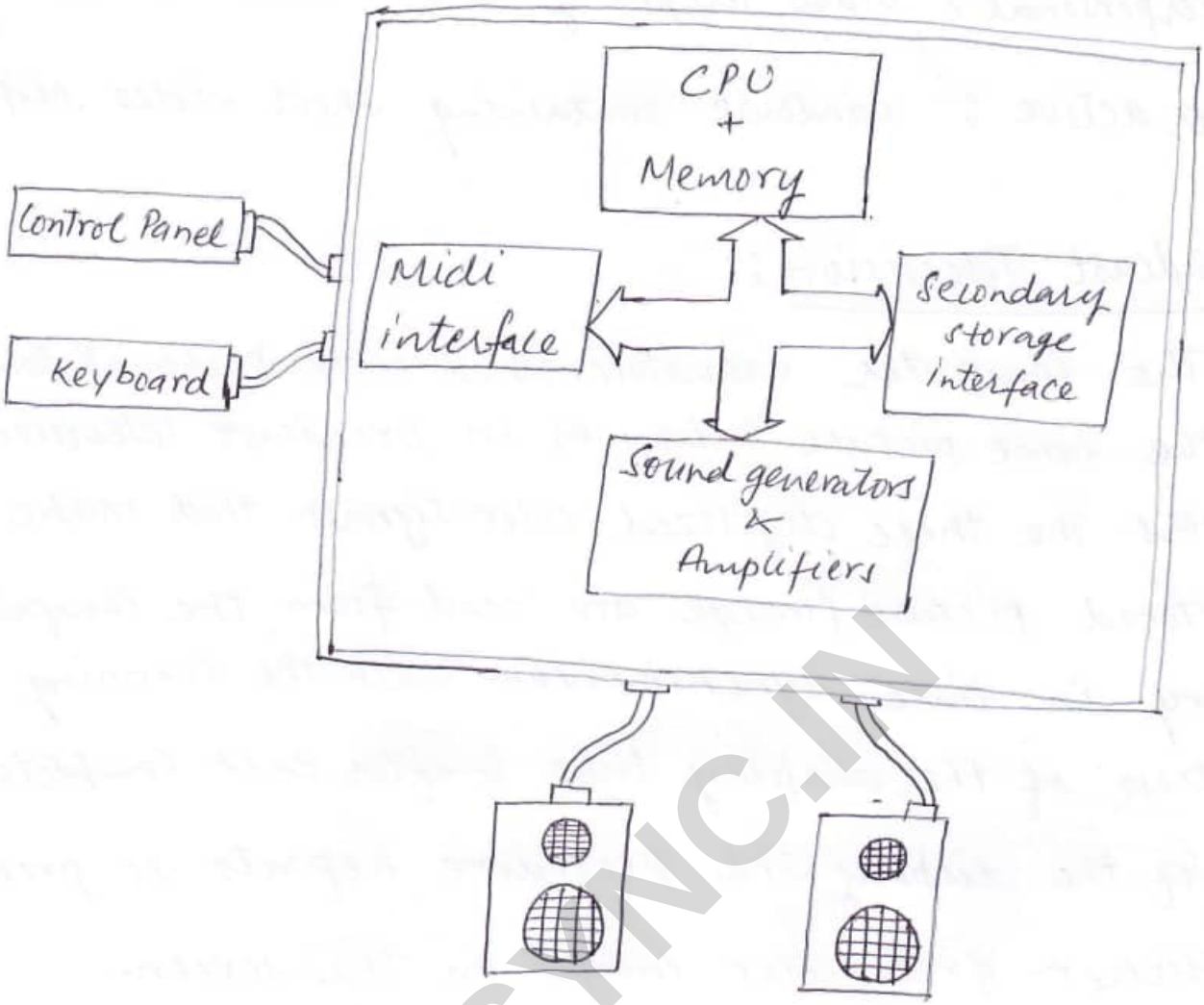

These are defined in a standard known as the the Music Instrument Digital Interface (MIDI). The format of a MIDI message consists of a status byte, followed by a number of data bytes which collectively define a set of parameters associated with the event.

VIDEO :

Video features in a range of multimedia Applications :

⇒ Entertainment : broadcast television & VCR/DVD recordings ;

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⇒ interpersonal: Video telephony and video conferencin

⇒ interactive: windows containing short video clips.

Broadcast Television:

The computer monitors used with personal comput use the same picture tube as in broadcast television receivers. The three digitized color signals that make up a stored picture/image are read from the computer memory in time-synchronisum with the scanning operation of the display tube & after each complete scan of the display, the procedure repeats so producin a flicker-free color image on the screen.

Scanning Sequence:

It is necessary to use a minimum refresh rate of 50 times/sec to avoid flicker. to produce smooth motion, a refresh rate of 25 times/sec is sufficient. To minimize the amount of transmission BW i.e required to broadcast the television signal, this characteristic of the eye is exploited by transmitting the image/picture associated with each frame in two halves. Each is known as a field. The two fields are then integrated together in the television receiver using a technique known as interlaced scanning

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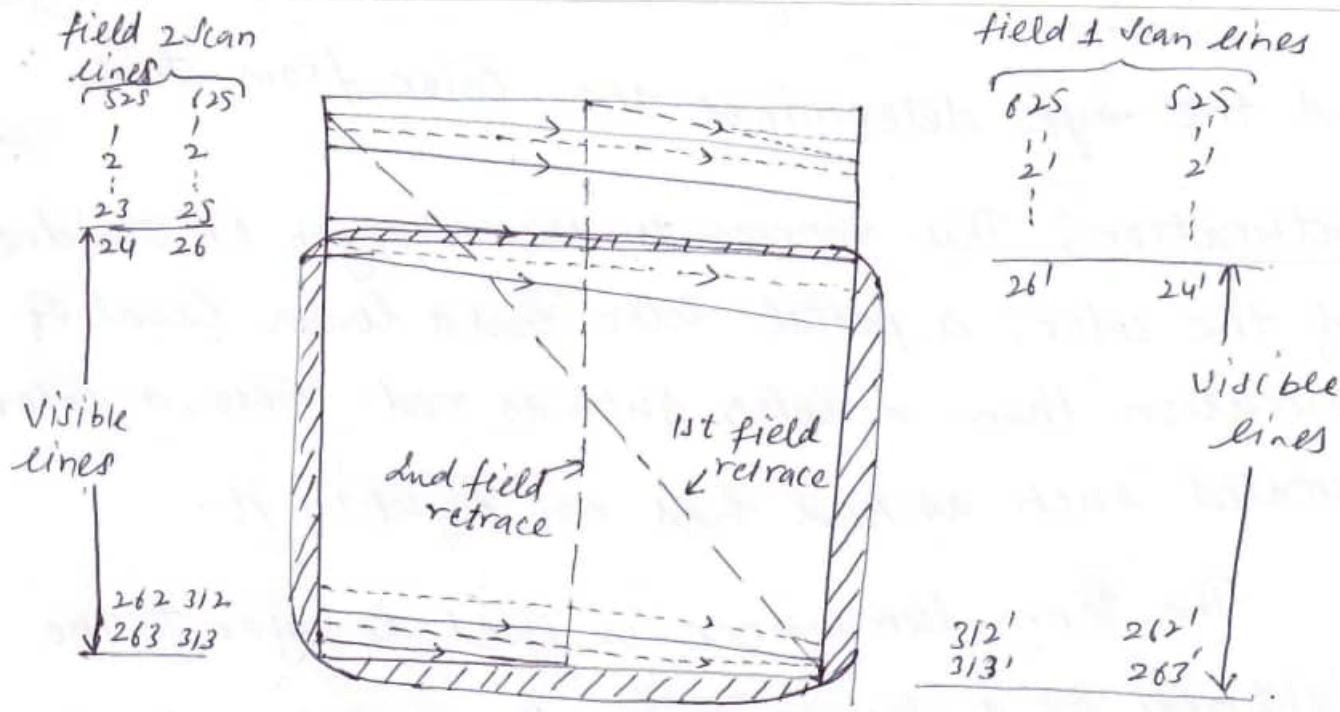

fig. Interlaced scanning Principles.

Color signals:

The received signals associated with a color TV broadcast had to be such that they could be used by an existing monochrome TV set to produce the same picture in high quality monochrome. A color TV had to be able to produce black & white pictures from monochrome broadcasts.

The three main properties of a color source that the eye makes use of are:

⇒ brightness: This represents the amount of energy that stimulates the eye & varies on a grayscale from black (lowest) through to white (highest). It is thus independent of the color of the source.

⇒ Hue: This represents the actual color of the source, each color [illegible]

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and the eye determines the color from this.

⇒ Saturation: This represents the strength or vividness of the color, a pastel color has a lower level of saturation than a colors such as red. Also, a color saturated such as Red has no light in it.

The term luminance is used to refer to the brightness of a source & the hue & saturation, because they are ~~connected~~ concerned with its color & are referred to its chrominance characteristics.

A Range of colors can be produced on a TV display screen by varying the magnitude of the three electrical signals that energise the red, green & blue phosphors.
Eg: if the magnitude of the three signals are in the proportion

$$0.299R + 0.587G + 0.114B$$

then white color is produced on the screen.
Luminance can be detertermined by summing together the three primary components that make up the color in this proportion. i.e

$$Y_S = 0.0299R_S + 0.587G_S + 0.144B_S$$

Where Y_S is the amplitude of the luminance signal & R_S, G_S & B_S are the magnitudes of the three color component signals that make up the source.

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Two other signals, the blue chrominance (C_b) & the red chrominance (C_r) are then used to represent the colorat of the source i.e hue & saturation. These are obtained from the two color diff. signals:

$$C_b = B_s - Y_s \quad \& \quad C_r = R_s - Y_s$$

Chrominance Components:

All color TV systems use this same basic principle to represent the coloration of a source, there are some small diff. b/w two systems in terms of the magnitude used for the two chrominance signals. These arise from the constraint that the BW of the xmissio channel for color broadcasts must be the same as that used for monochrome. In order to fit the Y, C_B & C_R signals in the same BW, the three signals must be combined together for transmission. The resulting signal is then known as the composite video signal.

~~Signal Bandwidth~~: For a PAL system, C_b & C_r are referred to as U & V resp. & the scaling factors used for three signals are:

$$Y = 0.299R + 0.587G + 0.114B$$
$$U = 0.493\,(B - Y)$$
$$V = 0.877\,(R - Y)$$

In case of NTSC, the two color diff. signals are combined to form two different signals referred to as I &C The scaling factors used are:

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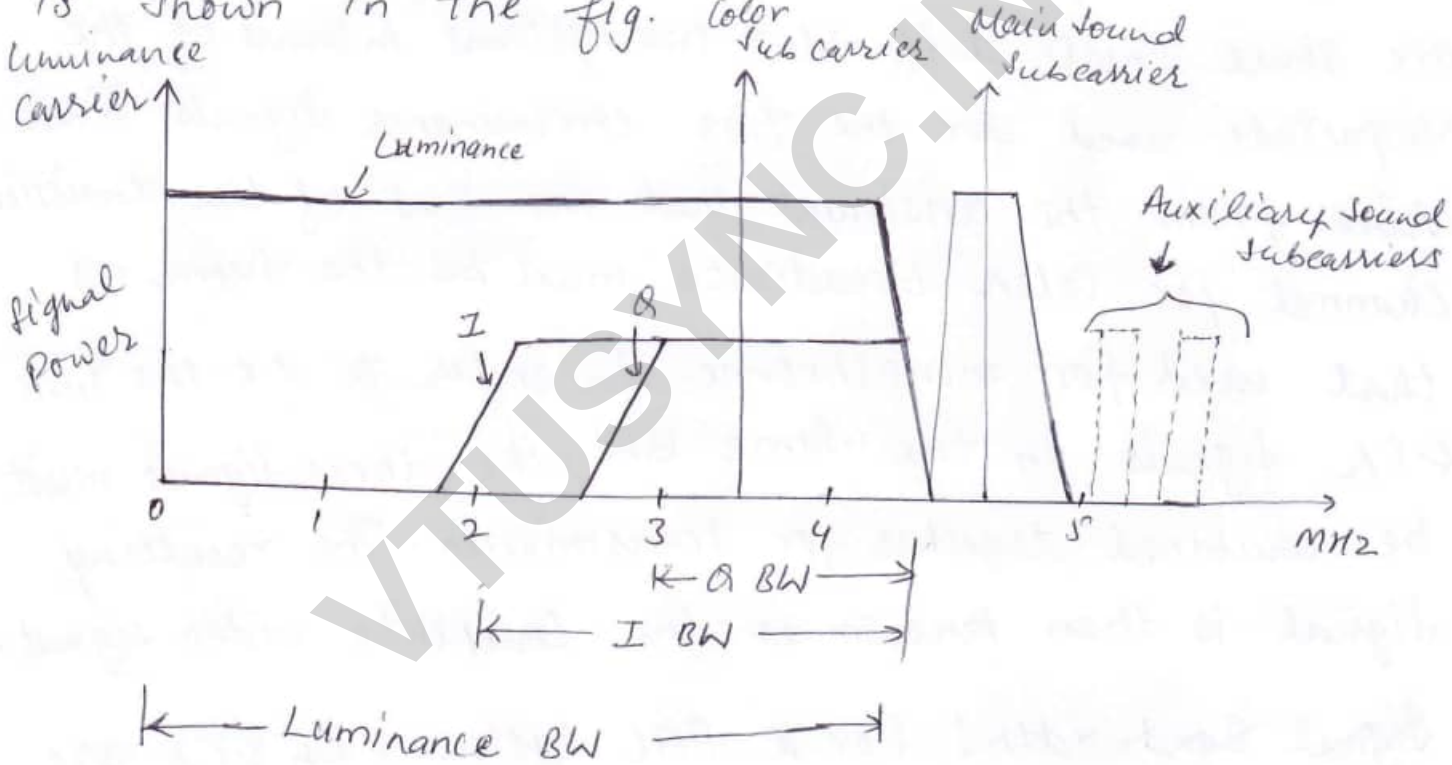
$$Y = 0.299R + 0.587G + 0.114B$$
$$I = 0.74(R-Y) - 0.27(B-Y)$$
$$Q = 0.48(R-Y) + 0.41(B-Y)$$

Signal Bandwidth:

The Bandwidth of the transmission channel used for color broadcasts must be the same as that used for a monochrome broadcast. The baseband spectrum of a color TV signal in both the NTSC & PAL systems is shown in the fig.



(a) Baseband Spectrum of color TV signals; NTSC System.

In the NTSC system the eye is more responsive to the I signal than the Q signal. Hence to Maximize the use of the available BW while at the same time minimizing the level of interference with the luminance signal, the I signal has the BW of about 2MHz & the Q signal a BW of about 1MHz.

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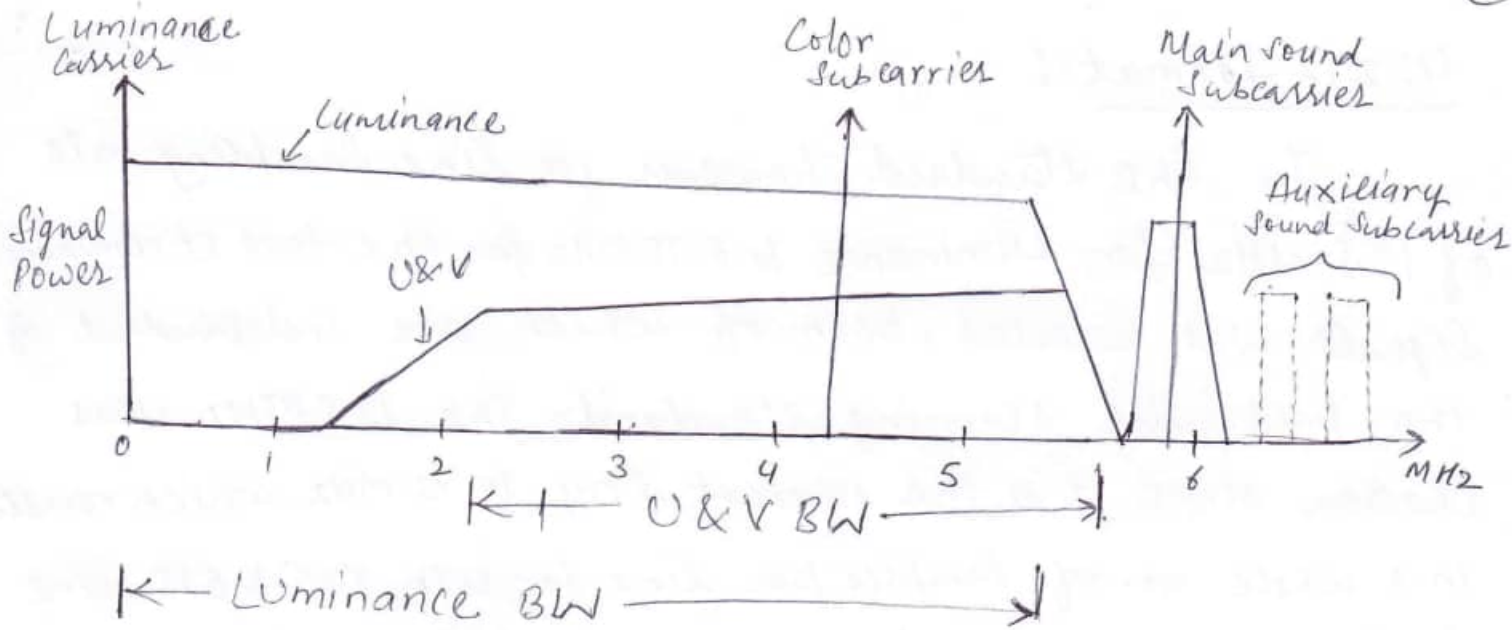

(b) Baseband Spectrum of Color TV Signal : PAL system

With a PAL system, the larger Luminance bW, about 5.5 MHz relative to 4.2MHz - allows both the U & V chrominance signals to have the same modulated BW which is about 8MHz.

DIGITAL VIDEO:

Digitization of video signals has been carried out in TV ~~Signals~~ studios in order to perform conversion from one video format into another. In order to standardize this process & hence make the exchange of TV programmes internationally easier, the International body for TV Standards - the International Telecommunications Union - Radio comm^{n} Branch (ITU-R). A no. of variants of this standard have been for use in other applications domain such as digital television broadcasting, video telephony & video conferencing

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4:2:2 format:

In the standard, however, a line sampling rate of 13.5 MHz for Luminance & 6.75 MHz for the two chrominance signals was selected, both of which are independent of the particular scanning standard. The 13.5 MHz was choosen since it is the nearest freq. to 12 MHz which results in a whole no. of samples per line for both 525 & 625 line systems.

In a 525-line system, the total line sweep time is 63.56 ms but during this time the beam is turned off-set to the black level - for retrace for 11.56 ms which yields an active line sweep time of 52 ms.

Ily, in a 625-line system, the total line sweep time is 64 ms with a blanking time of 12ms which also yields an active line sweep time of 52 ms. In both cases, a sampling rate of 13.5 MHz yields:

$$52 \times 10^{-6} \times 13.5 \times 10^{6} = 702 \text{ samples per line.}$$

4:2:0 format:

This format is a derivative of 4:2:2 format & is used in digital video broadcast applications. It is derived by using same set of Chrominance samples for two consecutive lines. For broadcast applications, interlaced scanning is used & the absence of chrominance samples in alternative lines is the origin of the term 4:2:0.

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This yields the same ~~chromi~~ Luminance resolution a the 4:2:2 format but half the chrominance resolution

525-Line System : $Y = 720 \times 480$

$C_b = C_r = 360 \times 240$

625 Line System : $Y = 720 \times 576$

$C_b = C_r = 360 \times 288$

The bit rate in both systems with this format is:

$$13.5 \times 10^6 \times 8 + 2(3.375 \times 10^6 \times 8) = 162 \text{ Mbps.}$$

HDTV formats ;

There are a no. of alternative digitization formats associated with high defination television (HDTV). The resolution of those which relate to the older 4/3 aspect ratio tubes can be up to 1440 × 1152 pixels & the resolution of those which relate to the newer 16/9 wide-screen tubes can be upto 1920 × 1152 pixels.

SIF:

The source intermediate format (SIF) uses half the spatial resolution in both horizontal & vertical directions as that used in the 4:2:0 format. The frame refresh rate is 30Hz for 525 line system and 25Hz for a 625-line system.

This yields resolution of:

525 line system: $Y = 360 \times 240$

$C_b = C_r = 180 \times 120$

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625 line system : $Y = 360 \times 288$

$C_b = C_r = 180 \times 144$.

The worst case bit rate in both systems with this format is :

$6.75 \times 10^6 \times 8 + 2(1.6875 \times 10^6 \times 8) = 81$ Mbps.

CIF:

The common intermediate format has been defined for use in video conferencing applications. This yields a spatial resolution of :

$Y = 360 \times 288$

$C_b = C_r = 180 \times 144$.

QCIF:

The quarter CIF (QCIF) format has been defined for use in video telephony applications. It is derived from the CIF & uses half the spatial resolution of CIF in both horizontal and vertical directions. and the temporal resolution is divided by either 2 or 4. This yields a spatial resolution of:

$Y = 180 \times 144$

$C_b = C_r = 90 \times 72$

The worst-case bit rate with this format is:

$3.375 \times 10^6 \times 8 + 2(0.84375 \times 10^6 \times 8) = 40.5$ Mbps

PC VIDEO: To achieve the necessary resolution with a 525-line monitor, the line sampling rate is reduced from 13.5 MHz to 12.2727 MHz while for a 625-line monitor, the line sampling rate must be increased from

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13.5 MHz to 14.75MHz. In case of desktop video telephony & videoconferencing the video signals from the camera are sampled at this rate prior to transmission & hence can be displayed directly on a PC screen.

VIDEO CONTENT:

In many interactive applications that involve video, the short video clips associated with the application are obtained by plugging a video camera into a video capture board within the computer i.e preparing the page contents. The computer stores the digitized video produced by such boards into a file ready for linking to the other page contents.

In other applications the video may be generated by a computer program rather than a video camera. This type of video content is normally referred to as computer animation. because of the way it is generated animated graphics.

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RECOMENDDED QUESTIONS:

1. Expalin codeword, analog signal, signal encoder, signal decoder?[06]
2. Define "bandwidth"? explain "bandlimiting channel"?[05]
3. Explain nyquist sampling theorem & nyquist rate?[04]
4. Define the meaning of term quantization interval & how this influences the accuracy of the sampling process of an analog signal? [06]
5. Explain a) unformatted/plain text.
   b) formatted/rich text.
   c) Hyper text. [06]
6. Differentiate formatted text & unformatted text? Explain origin the acronym WYSIWYG? [05]
7. Explain briefly: visual object, freeform object, clip art, 3-D objects.[04]
8. Explain scanning, pels, digitization principles wrf to fascimile machines?[08]
9. Define the aspect ratio of a display screen.give two examples for current widely used screen sizes? [05]
10. Derive the time to transmit an image with each type of display assuming a bitrate of 56 kbps, 1.5Mbps?[06]
11. Define text & image.[03]
12. Define audio & video.[03]
13. Compare formatted & unformatted text.[08]
14. What is rendering & clip art?[02]
15. What is flicker & frame refresh rate?[04]
16. What is NTSC & PAL?[10]
17. What is sample & hold, Quantizer?[06]
18. Define aspect ratio & pixel depth.[06]
19. What is composite video signal?[04]
20. Define Run – length encoding & statistical encoding.[06]
21. What is synchronization?[02]
22. Identify the main features of the MIDI standard & its associated message?[08]
23. State & explain three main properties of a color source that the eye makes of?[08]
24. Why is the chrominance signal transmitted in the form of two color different signals?[08]
25. Derive the bit rate that results from the digitization of a 525-line and a 625-line system using the 4:2:0 digitization format and interlaced scanning. Hence derive the amount of memory required to store a 2-hour movie/video?[10]

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